

Wind and Wind Stress Measurements in HiRes

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LONG-TERM GOALS

The long-term goal is to further the understanding of air-sea interaction processes including momentum, heat, water vapor, surface and boundary layer dynamics under various meteorological and oceanographic conditions.

OBJECTIVES

The objective of this grant is to measure and analyze the wind, wind stress and associated quantities at sea in the High Resolution Air-Sea Interaction DRI (HiRes). The practical objectives of HiRes are the determination of how well ship-based radars can measure the phase-resolved surface wave field (PRSWF), testing the skill of highly-nonlinear numerical surface wave models to predict the evolution of the PRSWF, and the incorporation of ocean wave effects into models of the Marine Atmospheric Boundary Layer (MABL).

APPROACH

The HiRes grant started in April 2008. The initial phase of the research is to design the experimental system to be conducted on R/P FLIP. Data from a past experiment are also being analyzed with respect to processes relevant to HiRes.

WORK COMPLETED

Testing of some of the instruments obtained with an associated DURIP equipment-only award has been done; a Wind Lidar and a GPS/Inertial motion unit. (See the DURIP award Annual Report.) A meeting of the HiRes meteorological component investigators was held at UCI.

For the HiRes experiment on R/P FLIP, the air temperature profile will be measured along with wind stress, surface heat flux, sea surface temperature, etc., to specify the buoyant stability of the surface layer. Since the adiabatic lapse rate is approximately 1 C per 100 meters, the measurement of the gradient from a set of fixed sensors is challenging. We have chosen precision thermistor sensors which offer the best accuracy over the narrow at-sea temperature range. In addition, the sensors have to be shielded from solar radiation. In the initial research on this grant we have investigated laboratory calibration of the temperature sensors and selection of the best solar radiation shield based on outdoor tests.

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RESULTS

In order for comparisons of the aspirated radiation shields to be accurate a Thermo Scientific NESLAB RTE-17 Bath was used to calibrate the thermistors used in the radiation shields. The calibration results shown in Table 1 for all sensors at 14.890 C show that the maximum deviation from the reference sensor is 0.005C.

Table 1: Thermistor Calibration Results

TEMP [°C]	MEAN [°C]	STD [°C]
T _{ref}	14.8903	0.003691
T RMY	14.8912	0.003444
T EGG1	14.8908	0.003349
T EGG2	14.8954	0.003809
T RMY _c	14.8891	0.006708

The calibrated thermistor sensors were used in two types of fan-aspirated radiation shields, RMYoung and EG&G (two) and a passive RMYoung flat-plate shield. Figure 1 shows the mounting of the radiation shields on a mobile workstation.

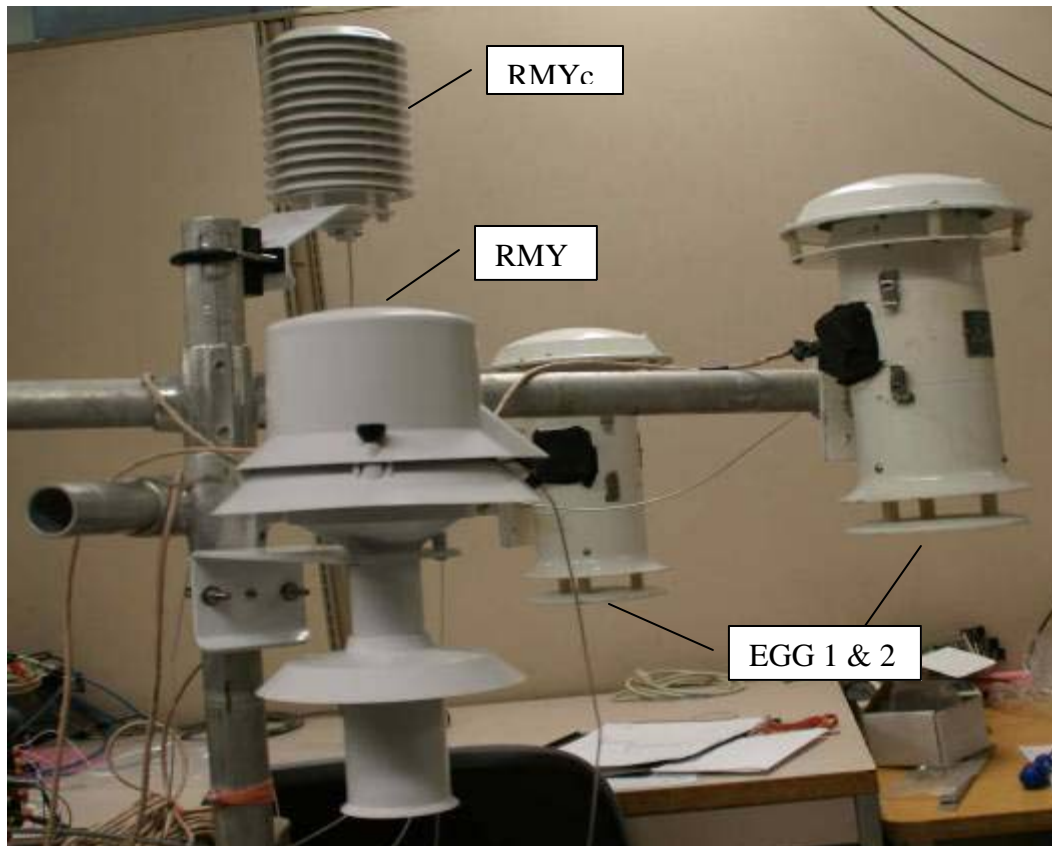


Figure 1: Solar radiation shields mounted on mobile workstation.

Figure 2 shows the results of the aspirated radiation shields tested under clear sky strong solar radiation. It was concluded that the T_RMY is the best radiation shield as it registered the lowest ambient air temperature by 0.14 to 0.21C, clearly above the calibration errors. (The flat-plate shield performed poorly and is not shown.)

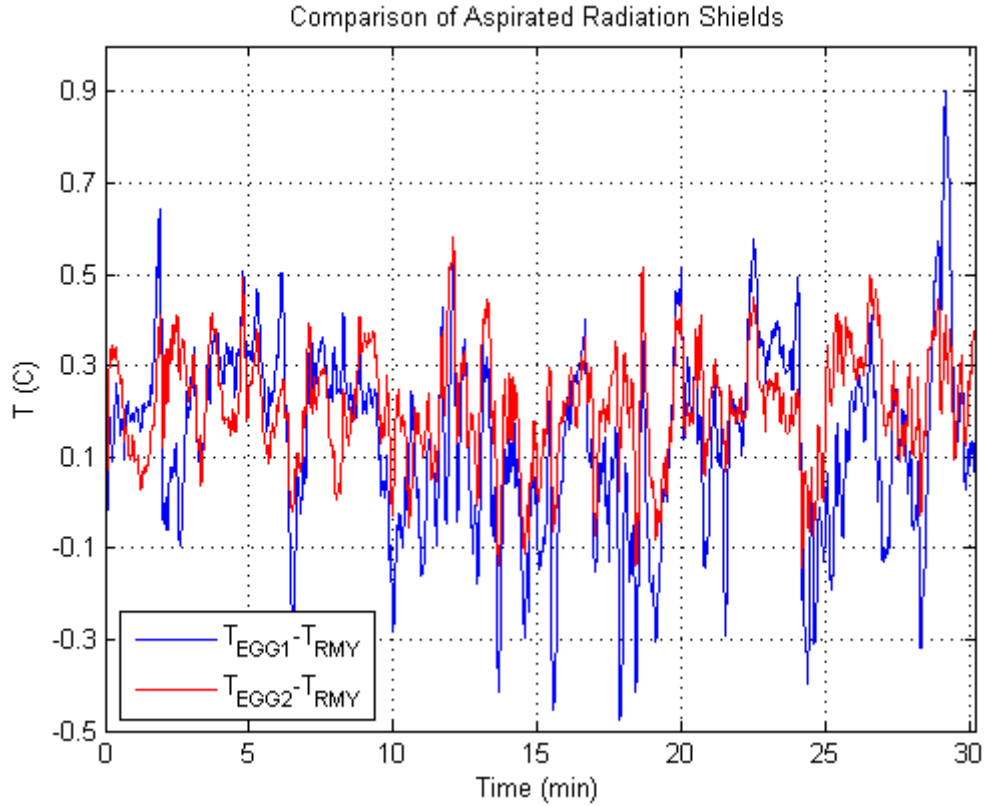


Figure 2: Comparison of Radiation Shields: Temperature Difference of EG&G Shields Relative to RM Young aspirated shield.

The quantitative results of the comparison are shown in Table 2.

Table 2: Solar Radiation Shield Temperatures

TEMP [°C]	MEAN [°C]	STD [°C]
Tref	26.5723	0.4135
T RMY	22.4696	0.3008
T EGG1	22.6088	0.2487
T EGG2	22.6811	0.2565
T RMYc	22.8148	0.2103

The highlighted value in Table 2 for the RM Young aspirated shield indicates that it performed the best as it registered the lower ambient temperature.

In preparation for the HiRes experiment onboard R/P FLIP a mast prototype was built in laboratory for testing the various sensors and for mounting arrangement. The mast was populated with the various

sensors that will be used during the HiRes experiment at sea. In addition to the R.M. Young aspirated radiation shields, the mast will support Met One Vanes (wind direction), Met One Cups (wind speed), Campbell Scientific CSAT3 (3D sonic anemometer), LI-COR LI-7500 (CO₂/H₂O Analyzer), and ParoScientific Met4a (pressure). Figure 2 shows a typical level of a mast prototype with the various sensors mounted. Approximately 5 levels of turbulence measurements will be made in the final configuration, 12 levels of wind speed, 5 levels of air temperature, and 4 levels of static pressure fluctuations.

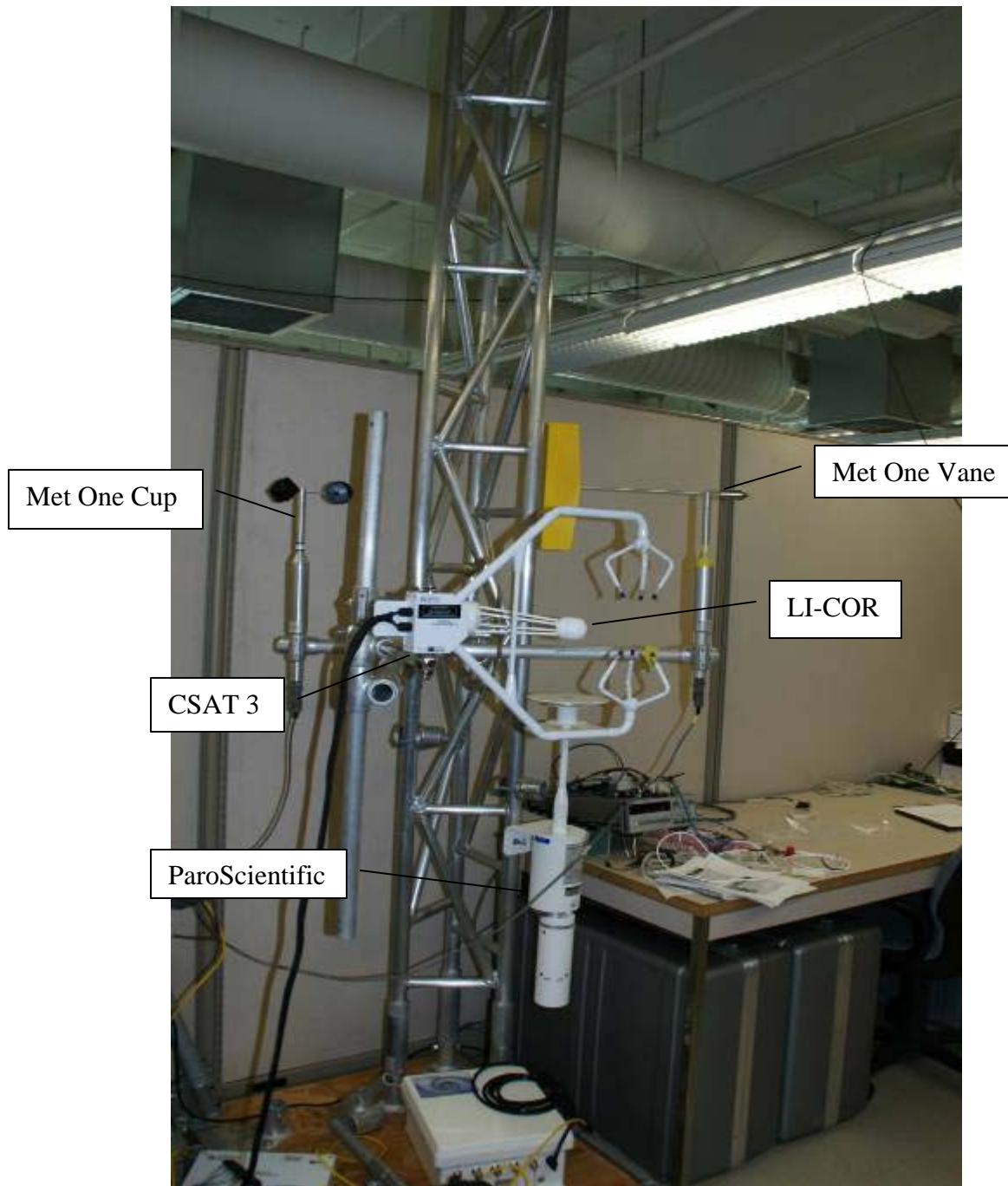


Figure 2: Prototype Mast with Sensor Array

IMPACT/APPLICATIONS

The initial application of these instruments will be in the ONR High Resolution Wind-Wave Departmental Research Initiative, FY2007-FY2011 during a trial cruise on R/P FLIP in Spring 2009 and the main experiment in Spring 2010.

TRANSITIONS

None

RELATED PROJECTS

DURIP grant

REFERENCES

Not applicable

PUBLICATIONS

Not applicable

PATENTS

Not applicable

HONORS/AWARDS/PRIZES

Not applicable